AMENDMENTS TO THE SPECIFICATION

Please replace the paragraph at page 2, lines 3-20, with the following amended paragraph:

As one of such pattern-detection apparatus, there is known an apparatus that recognizes a partial image having a predetermined shape and size and being part of a specific pattern, based on condition that (1) the number of ON-pixel within m×n pixel rectangle block area in the ~~neighbrhood~~ neighborhood of [[an]] a target pixel falls within a predetermined range, and that (2) no ON-pixel exists within a predetermined area in the neighborhood of said block area, after low-resolution converting a binary data. However, this pattern-detection apparatus cannot precisely identify a partial image, in particular, having an empty inside and often wrongly detects another image, such as a circular image having an all over painted inside or a quadrilateral or triangular image composed of multiple pixels of the same size, with the desired partial image. Also, this pattern recognition apparatus cannot precisely identify the shape of a partial image and often wrongly detects for the desired image, another image such as an L-shaped image or diagonal line.

Please replace the paragraph beginning at page 3, line 18, and ending on page 5, line 1, with the following amended paragraph:

To achieve the above object, in an aspect of the invention, there is provided a pattern-detection apparatus that detects a specific pattern contained in an image. The pattern-detection apparatus has a binarizing unit that binarizes an input image to obtain binary image data, a partial-image recognition unit that recognizes a partial image that is contained in the binary image data, and that is part of the specific

pattern and has an empty inside, and a specific pattern determination unit that determines the specific pattern contained in the image, based on the recognition results obtained by the partial-image recognition unit. The partial-image recognition unit successively scans, for the binary image data, a pixel-block area of predetermined size containing [[an]] a target pixel and recognizes a partial image contained in the binary image data, on the condition that at least one OFF-pixel exists within a reference block consisting of the target pixel and predetermined pixels in its neighborhood. Also, the partial-image recognition unit may change the size of the reference block, depending on the size of the partial-image to be recognized within the pixel-block area. Further, the above partial-image recognition unit may recognize the partial image on at least one of the conditions that the pixels constituting the outermost lines of a pixel-block area are all OFF-pixels, and that the number of ON-pixels contained in a predetermined area with its center being at [[an]] a target pixel in said pixel-block area is within a prescribed range. Further, the pattern-detection apparatus may have a low-resolution conversion unit that converts the binary image data obtained by the binarizing unit to binary image data of lower resolution, and the partial-image recognition unit may recognize the partial image for the binary image data converted to lower-resolution image data by the low-resolution conversion unit.

Please replace the paragraph at page 5, lines 2-16, with the following amended paragraph:

Also, in another aspect of the present invention, there is provided a method for detecting a specific pattern contained in an image. The pattern-detection method

has steps of binarizing input image data to obtain binary image data, recognizing a partial image that is contained in the binary image data, and that is part of the specific pattern, and has an empty inside, and determining the specific pattern contained in the image based on the recognition results. In the partial-image recognition step, a pixel-block area of predetermined size containing [[an]] a target pixel is successively scanned for the binary image data, and a partial image contained in the binary image data is recognized on the condition that at least one OFF-pixel exists within a reference block consisting of [[an]] a target pixel and predetermined pixels in its neighborhood.

Please replace the paragraph beginning at page 5, line 17, and ending on page 6, line7, with the following amended paragraph:

Further, in another aspect of the present invention, there is provided a computer-readable storage medium that stores a pattern-detection program for detecting a specific pattern contained in an image. The pattern-detection program has steps of binarizing an input image to obtain binary image data, recognizing a partial image that is contained in the binary image data, and that is part of the specific pattern, and has an empty inside, and determining the specific pattern contained in the image based on the recognition results. In the partial-image recognition step, a pixel-block area of predetermined size containing [[an]] a target pixel is successively scanned for the binary image data, and a partial image contained in the binary image data is recognized on the condition that at least one OFF-pixel exists within a reference block consisting of an target pixel and predetermined pixels in its neighborhood.

Please replace the paragraph beginning at page 8, line 18, and ending on page 10, line 6, with the following amended paragraph:

In another aspect of the invention, there is provided a pattern-detection apparatus that detects a specific pattern contained in an image. The pattern-detection apparatus has a binarizing unit that binarizes an input image data to obtain binary image data, a partial-image recognition unit that recognizes a partial image that is contained in the binary image data and that is part of the specific pattern, and a specific pattern determination unit that determines the specific pattern contained in the image based on the recognition results obtained by the partial-image recognition unit. The partial-image recognition unit recognizes a partial image contained in the binary image data, for a pixel-block area having predetermined size and containing [[an]] a target pixel in the binary image data, based on at least one of the conditions concerning the pixels at the opposite vertices, the pixels on the outermost lines of the pixel-block area, and the pixels on the opposite sides on the outermost lines of the pixel block. The partial image may be approximately a circular image. Also, the condition for the partial-image recognition in the partial-image recognition unit may be that the number of OFF-pixels in each pixel pair that is located at opposite vertices is less than 2. Further, the condition for the partial-image recognition in the partial-image recognition unit may be that the total number of ON-pixels on the outermost lines is not more than a predetermined number, for the pixels on the outermost lines of the pixel-block area. Still further, the condition for the partial-image recognition in the partial-image recognition unit may be that the total number of ON-pixels on the outermost lines is not more than a predetermined number, for

the pixels on each pair of opposite sides on the outermost lines of the pixel-block area. Further, the pattern-detection apparatus may have a low-resolution conversion unit that converts the binary image data obtained by the binarizing unit to binary image data of lower resolution, and the partial-image recognition unit may recognize the partial image for the binary image data converted to lower-resolution image data by the low-resolution conversion unit.

Please replace the paragraph at page 10, lines 7-23, with the following amended paragraph:

Also, in another aspect of the present invention, there is provided a method for detecting a specific pattern contained in an image. The pattern-detection method has steps of binarizing input image data to obtain binary image data, recognizing a partial image that is contained in the binary image data, and that is part of the specific pattern, and has an empty inside, and determining the specific pattern contained in the image based on the recognition results. In the partial-image recognition step, the partial image contained in the binary image data is recognized, for a pixel-block area having predetermined size and containing [[an]] a target pixel in the binary image data, based on at least one of the conditions concerning the pixels at the opposite vertices, the pixels on the outermost lines of the pixel-block area, and the pixels on each pair of opposite sides on the outermost lines of the pixel-block area.

Please replace the paragraph beginning at page 10, line 24, and ending at page 11, line 15, with the following amended paragraph:

Further, in another aspect of the present invention, there is provided a computer-readable storage medium that stores a pattern-detection program for detecting a specific pattern contained in an image. The pattern-detection program has steps of binarizing input image data to obtain binary image data, recognizing a partial image that is contained in the binary image data, and that is part of the specific pattern, and determining the specific pattern contained in the image based on the recognition results. In the partial-image recognition step, the partial image contained in the binary image data is recognized, for a pixel-block area having predetermined size and containing [[an]] a target pixel in the binary image data, based on at least one of the conditions concerning the pixels at the opposite vertices, the pixels on the outermost lines of the pixel-block area, and the pixels on each pair of opposite sides on the outermost lines of the pixel-block area.

Please replace the paragraph beginning at page 18, line 23, and ending at page 19, line 16, with the following amended paragraph:

Fig. 5 is a block diagram that represents the configuration of the element-recognition processor 24 in the pattern-detection processor 20. This element-recognition processor 24 has an element-candidate determiner 31 that evaluates recognition objects in the image data based on predetermined conditions to identify recognition objects satisfying the conditions as element candidates, an element-candidate-size detector 32 that detects the size of the recognition object identified as an element candidate, an OFF-pixel detector 33 that detects OFF-pixels that exist in a reference block within a pixel block area containing the recognition object, which consists of [[an]] a target pixel and predetermined pixels in its neighborhood, and a

final element determiner 34 that determines a final element depending on the determination and detection results by these components. In this first embodiment, the reading and writing of data performed by the element-recognition processor 24 for RAM 13 are controlled by a memory controller 18.

Please replace the paragraph at page 19, lines 17-25, with the following amended paragraph:

It is noted that [[an]] a "target pixel" represents a reference pixel that is located at the center or its neighborhood of each pixel-block area, when pixel-block areas in the image data are successively scanned, during the element-recognition processing, by a filter of m×n size in which an element can be framed. An "OFF-pixel" is a pixel having value 0 in binary image data, that it is a pixel in which a point does not exit. These definitions are also applied hereinafter.

Please replace the paragraph at page 20, lines 1-11, with the following amended paragraph:

The memory controller 18 derives, during the element-recognition processing, the address on RAM 13 where the binary image data is stored, and successively reads pixel-block areas in the binary image data from RAM 13. These pixel-block areas are rectangular block-areas consisting of m×n pixels with its center being at [[an]] a target pixel. The size of a pixel-block area is determined based on processing resolution and the size of an ideal element. The pixel-block areas read by the memory controller 18 are input to the element-candidate determiner 31 and the OFF-pixel detector 33.

Please replace the paragraph at page 20, lines 12-21, with the following amended paragraph:

The element-candidate determiner 31 evaluates recognition objects in input pixel-block areas based on predetermined conditions to identify recognition objects satisfying the conditions as element candidates. The predetermined conditions are that (1) the pixels constituting the outermost lines of a pixel-block area are all OFF-pixels, and that (2) the number of ON-pixels contained in a predetermined area with its center being at [[an]] a target pixel in the pixel-block area is within a prescribed range.

Please replace the paragraph beginning at page 20, line 22, and ending on page 21, line 21, with the following amended paragraph:

For example, as shown in Fig. 6, an ideal element is a circular image having an empty inside such that, in a 4×4 pixel-block area, ON-pixels are arranged on the upper, lower, left and right sides, and OFF-pixels are arranged at the four corners and the middle 2×2 pixel-block area. In Fig. 6, the pixels indicated by crosshatching are ON-pixels. For this ideal element, element-candidate determination is performed in a 7×7 pixel-block area. In this case, corresponding to the above conditions (1) and (2), the following conditions are established. The pixels constituting the outermost lines of the 7×7 pixel-block area are all OFF-pixels, and the number of ON-pixels contained in a 5×5 pixel-block area with its center being at [[an]] a target pixel in the 7×7 pixel-block area falls within 6 to 10. As a result of the evaluation based on these conditions, various recognition objects contained in a 7×7 pixel-block

area as shown in Fig. 7A - 7D are identified as element candidates. Although these recognition objects differ in shape or size from the ideal element shown in Fig. 6, they are identified as element candidates, since they satisfy the above conditions (1) and (2). In contrast, various recognition objects contained in a 7×7 pixel-block area as shown in Fig. 8A - 8D are not identified as element candidates, since they do not satisfy at least one of the above conditions (1) and (2).

Please replace the paragraph beginning at page 22, line 14, and ending at page 23, line 1, with the following amended paragraph:

The OFF-pixel detector 33 receives the detection results from the element-candidate-size detector 31, and based on these detection results, extracts the pixel-block corresponding to the size of the detection object from a pixel-block area input from RAM 13 through memory controller 18. Next, in the extracted pixel-block, the OFF-pixel detector 33 sets a reference block consisting of [[an]] a target pixel and the pixels in its predetermined neighborhood and detects OFF-pixels within the reference block. If detecting some OFF-pixels within the reference block, then the OFF-pixel detector 33 determines that the recognition object contained in the pixel-block area is an element having an empty inside.

Please replace the paragraph at page 23, lines 2-7, with the following amended paragraph:

Fig. 9A to 9H show examples of set reference blocks in various pixel-blocks extracted as pixel-blocks corresponding to the sizes of recognition objects. In the illustrated various pixel-blocks, a pixel marked with [[a]] an asteroid-shaped symbol

represents [[an]] a target pixel, and an area indicated by crosshatching is a reference block.

Please replace the paragraph beginning at page 30, line 17, and ending at page 31, line 5, with the following amended paragraph:

The element-candidate determiner 61 evaluates recognition objects in input pixel-block areas based on predetermined conditions to identify recognition objects satisfying the conditions as element candidates. The predetermined conditions are that (1) the pixels constituting the outermost lines of a pixel-block area are all OFF-pixels, and that (2) the number of ON-pixels contained in a predetermined area with its center being at [[an]] a target pixel in the pixel-block area falls within a prescribed range. The determination processing is the same as the processing performed by the element-candidate determiner 31 described with reference to Figs. 6 to 8 in the first embodiment described above, and so, the description is omitted.

Please amend the paragraph beginning at page 31, line 23, and ending on page 32, line 14, with the following amended paragraph:

The determination processing performed by the opposite-vertices determiner 62 is explained with reference to Fig. 12. The object to be processed is a 5×5 pixel-block area that contains a recognition object with its center being at [[an]] a target pixel. In this 5×5 pixel-block area, there exist pixel pairs (A, A') and (B, B') located at opposite vertices. In the determination, A+A', and B+B' are evaluated, where the value for an ON-pixel is 1 and the value for an OFF-pixel is 0. Then, if

$$A + A' < 2 , \quad \text{and}$$

$$B + B' < 2,$$

then the recognition object in the 5×5 pixel-block area is identified as an element. According to this determination processing, recognition objects having two pixels at opposite vertices can be excluded, so that a recognition object agreeing with the ideal element shown in Fig. 6 can be selected.

Please replace the paragraph beginning at page 32, line 19, and ending on page 33, line 14, with the following amended paragraph:

The outermost-lines determiner 63 determines pixel information on the outermost lines of the second pixel-block area containing a recognition object. That is, the second pixel-block area containing a recognition object is evaluated based on the condition that the number of ON-pixels on the outermost lines is not larger than a predetermined number. This determination process is explained here with reference to Fig. 13. The object to be processed is a 5×5 pixel-block area that contains a recognition object with its center being [[an]] a target pixel. In this 5×5 pixel-block area, there exist outermost lines E1 and E5 in the horizontal direction and Ea and Ee in the vertical direction. In the determination, E1, E5, Ea and Ee are evaluated, where the value for an ON-pixel is 1 and the value for an OFF-pixel is 0. Then, if

$$E1 \leq 4$$

$$E5 \leq 4$$

$$Ea \leq 4, \text{ and}$$

$$Ee \leq 4,$$

then the recognition object within the 5×5 pixel-block area is determined to be an element.

Please replace the paragraph beginning at page 33, line 19, and ending at page 34, line 13, with the following amended paragraph:

The outermost-line opposite-sides determiner 64 determines pixel information on opposite sides of the outermost lines in the second pixel-block area containing a recognition object. The second pixel-block area containing a recognition object is evaluated based on the condition that the number of ON-pixels on each pair of outermost lines that constitute opposite sides is not larger than a predetermined number. The determination processing is explained here with reference to Fig. 14. The object to be processed is a 5×5 pixel-block area that contains a recognition object with its center being at [[an]] a target pixel. In this 5×5 pixel-block area, there exist the outermost line pairs (E1, E5) and (Ea, Ee) that constitute opposite sides. In the determination, E1+E5 and Ea+Ee are evaluated, where the value for an ON-pixel is 1 and the value for an OFF-pixel is 0. Then, if

$$E1 + E5 \leq 5, \text{ and}$$

$$Ea + Ee \leq 5,$$

then the recognition object in 5×5 pixel-block area is identified as an element.

Please replace the paragraph beginning at page 41, line 21, and ending on page 42, line 9, with the following amended paragraph:

The element-candidate determiner 71 evaluates recognition objects in input pixel-block areas, based on predetermined conditions, to identify recognition objects satisfying the conditions as element candidates. The predetermined conditions are that (1) the pixels constituting the outermost lines of a pixel-block area are all OFF-

pixels, and that (2) the number of ON-pixels contained in a predetermined area with its center being at [[an]] a target pixel in the pixel-block area falls within a prescribed range. The determination processing is the same as the processing performed by the element-candidate determiner 31 in the first embodiment and described with reference to Figs. 6 to 8. Therefore the explanation is omitted.

Please replace the Abstract with the following amended Abstract, which follows on a separate page: